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can be readily accounted for; and that among the "other causes" from which the death rates are diminished *pulmonary tuberculosis*, *pneumonia* and *infant mortality* are prominent.

Finally, we have raised the questions, To what is this remarkable result of the substitution of pure for polluted water due? Is the marked decline in the total death-rate attributable simply to cessation of infection; or is it due to some enhancement of vital resistance; or is it due to the cooperation of these factors? In other words, must pulmonary tuberculosis, pneumonia, infant mortality, etc., be added to the list of water-borne diseases, or does the use of impure water depress the vital resistance of the human organism?

The complete paper, containing a discussion of these and similar questions, numerous statistical tables, diagrams, etc., will be published in the near future.

W. T. SEDGWICK
SCOTT MACNUTT

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THE THIRTY-EIGHTH GENERAL MEETING
OF THE AMERICAN CHEMICAL
SOCIETY—II.

BIOLOGICAL AND SANITARY CHEMISTRY
THOMAS B. OSBORNE, *Chairman*

The Effect of Pasteurization upon the Development of Ammonia in Milk: W. G. WHITMAN and H. C. SHERMAN.

The purpose of this investigation was to follow by accurate quantitative determination the development of ammonia in raw and pasteurized milk as a possible measure of protein decomposition. The ammonia content of raw milk kept at 15° to 20° C. usually increased rather rapidly for two days, more slowly during the third and fourth days, and then decreased somewhat for a few days following, increasing again later if the observations were sufficiently prolonged. A similar slight decrease of ammonia toward the end of the first week was sometimes, but not usually, observed in milk pasteurized at 65°; never in milk pasteurized at 85°, which always showed a continuous increase in ammonia content. In milk obtained under ordinary market conditions in New York City and thereafter kept at 15–20°, pasteurization was usually less efficient in check-

ing the development of ammonia than in checking the production of acid, and this was especially true of the milk pasteurized at the higher temperature (85°) which often developed a relatively large amount of ammonia before becoming sour.

Chemical Evidence of Peptonization in Raw and Pasteurized Milk: RACHEL H. COLWELL and H. C. SHERMAN.

An attempt was made to judge roughly of the extent of peptonization from the intensity of the biuret reaction after the removal of coagulable proteins and proteoses. The results indicate that pasteurization at 60° for twenty minutes restrained peptonization to about the same extent that it restrained souring, and had no marked influence upon the development of offensive odors. Pasteurization at higher temperatures (75° and 90°) delayed souring to a much greater extent, had less restraining effect upon peptonization and resulted in the subsequent development of much more offensive odors.

Investigations of Wheat Oil: JOSEPH S. CHAMBERLAIN and GEO. L. BIDWELL.

The authors determined the physical properties, the iodine absorption, saponification value and refractive index of the crude fats extracted by ether from wheat germ and from wheat flour. The crude fats were then purified by treatment with acetone. The soluble portions consisting in each case of pure liquid oil were studied in the same way. The results show that the purified oils obtained from wheat germ and wheat flour are much more alike than the crude fats. They think it possible that the usual statement, that these two oils are distinctly different, may not be true and expect to study the question further.

Plant Food removed from Growing Plants by Rain or Dew: J. A. LE CLERC and J. F. BREAZEALE.

Wheat, barley and other plants were grown in pots in a greenhouse and not subjected to weathering conditions. It was demonstrated that the gradual decrease in the total salt content of these crops from the milk stage until final harvest is not due to a physiological process, as was formerly supposed by many investigators, but to a purely mechanical one. The salts do not recede from the plants to the soil through the stems, but are dissolved and leached out by rain or dew.

Analytical data were also cited to show that the same process takes place in potato, rice and oat plants and also in the leaves of trees.

On the Behavior of Lecithin with Bile Salts and the Occurrence of Lecithin in Bile: J. H. LONG and FRANK GEPHART.

The occurrence of lecithin in bile is still a disputed question. From work on the bile of the polar bear Hammarsten concluded some years ago that lecithin is a normal constituent of the bile of this animal. The evidence was indirect, as the presence of the lecithin was inferred from the recognition of certain decomposition products. Failing to effect a separation ourselves, we have attempted to show the presence of lecithin in ox bile in other ways. In preparing pure bile salts, in this case a mixture of taurocholate and glycocholate of sodium, it was found that they contained about 0.3 per cent. of phosphorus. This observation has been frequently made and is one of the grounds on which the lecithin content is assumed. We have determined the sulphur, the nitrogen, the phosphorus and the optical rotation of these salts, and the results may be best explained by assuming the presence of about 7.5 per cent. of the lecithin body. For various reasons, however, the calculation can not be exact. We have determined the extent of the solvent action of bile salts on lecithin and find that 100 parts of the former will dissolve almost exactly 80 parts of the latter to yield a clear solution. This solvent action is much hastened by the presence of many inorganic salts, but the weight dissolved is not increased. We have found the optical rotation of a mixture made in the above proportions, the results of which justify the figures given some years ago by Ulpiana for the rotation of egg lecithin, assuming that in our mixture the one active body does not interfere with the other. We believe this assumption to be correct, or, in other words, that the solution of the lecithin in the bile salt solution is a physical rather than a chemical phenomenon. We have carried out some experiments to show the extent to which these artificial mixtures of lecithin and bile salts may be separated from each other, and conclude from the results found that there is but little prospect that the very small amount of the lecithin which may occur in bile may be actually separated and identified as such.

Some Experimental Studies on Indigestible Carbohydrates: VICTOR C. MYERS. (From the Sheffield Laboratory of Physiological Chemistry, Yale University.)

The purpose of this investigation was to determine quantitatively the digestibility of Ice-

land moss, *Cetraria islandica*, in man. In three experiments on two different individuals, the raw *cetraria* carbohydrate was almost completely recovered in the stools. In one experiment in which the material was thoroughly boiled there seemed to be a slight utilization. Two experiments recently made by Mr. MacArthur, in this laboratory, with one of the isolated carbohydrates, lichenin, indicate the possibility of its complete utilization. This is certainly different from what beaker digestions would lead us to expect. It is hoped by further investigation the coming year to finally solve this problem.

The Effect of Phytic Acid and its Salts on Plants: OSWALD SCHREINER and M. X. SULLIVAN.

Wheat seedlings growing in soil were found to affect the fertility of this soil in such a way that the seedling crop of wheat was retarded in growth. Among the products of germination there was found by Patten and Hart's method a small amount of phytic acid or anhydro-oxyethylene diphosphoric acid. Accordingly, this acid and its salt were tested as to their effect on wheat. Phytic acid was found to be toxic to wheat in solutions as weak as five parts per million. Its sodium and potassium salts, on the contrary, were decidedly beneficial. The toxicity of the free acid is greater than the toxicity of phosphoric acid containing the same amount of P_2O_5 . The increase in transpiration and green weight in solutions of the potassium and sodium phytinate is about the same as the increase given by di-potassium and di-sodium phosphate containing the same amount of P_2O_5 . Phytic acid and its salts appear to play an important rôle in plant synthesis.

A Study of the Forms of Nitrogen in the Urine of Herbivora receiving Nutrients from a Single Plant Source: E. V. MCCOLLUM and E. B. HART.

Three lots of calves have been fed for more than a year with rations derived from a single plant source. These rations were respectively corn, wheat and oats, and their products. A standard lot received a mixture of the above grains and their products. The object of the experiment is to study biologically the value of proteids from different plants for the nutrition of animals. An extended study is being made of the metabolism of these animals, but most of the data are as yet too incomplete to be reported. Of the total nitrogen digested, the following per cent. was eliminated in the urine:

Corn-fed animal	31.98
Wheat-fed animal	54.86
Oat-fed animal	41.51
Mixture-fed animal	55.97

These figures are the averages for seven days' record for each animal. The form in which the nitrogen appeared in the urine of each of these calves was determined for a period of two days during which the urine and feces were collected quantitatively. The forms estimated were ammonia, urea, uric acid, purin bases, hippuric acid, kreatinin, kreatin and allantoin. The following are the more conspicuous results. (1) The high percentage of urea compared to that of hippuric acid. The urea ranged between 62.05 and 82.41 per cent. and the hippuric acid between 1.26 and 9.05 per cent. of the total nitrogen. Urea was uniformly higher and hippuric acid lower in wheat-fed calves than in the other lots. Corn-fed calves excreted less nitrogen as urea and more as hippuric acid than the other lots. (2) The kreatinin output calculated in terms of the total nitrogen excreted was very much higher in corn-fed calves than in other lots. Averages: for oat lot, 3.69; wheat lot, 3.01; corn lot, 9.08; mixture lot, 4.57; per cent. of the total nitrogen. (3) The total absence of allantoin from the urines of all wheat-fed calves. Allantoin was present in the urine of the other lots in amounts varying from 3.99 to 11.76 per cent. of the total nitrogen.

The Behavior of Alanin in Metabolism: GRAHAM LUSK.

On giving twenty grams of *l*-alanin to a dog made diabetic by phlorhizin injections, sugar increased in the urine in an amount to indicate an almost complete (93 per cent.) conversion of alanin into dextrose. This coincides with previous experiments by Mandel and Lusk which showed a complete conversion of lactic acid into dextrose within the organism.

On a Globulin from the Egg Yolk of the Spiny Dog-fish: C. A. ALSBERG and E. D. CLARK.

The yolk does not contain a typical vitelline: but in its stead a globulin free from phosphorus and perhaps iron. This may be due to the fact that the animal is viviparous.

On the Utilization of Inorganic Phosphorus by Animals: E. B. HART and E. V. MCCOLLUM.

This work embraces experiments extending over a period of two years with growing pigs. The results clearly indicate that inorganic phosphates, such as bone ash, finely ground rock phos-

phate, or precipitated calcium phosphate—a mixture of di- and tri-calcium phosphates—can be used by these animals where rations containing insufficient phosphorus are being fed. Young animals of forty pounds weight, receiving inorganic phosphate, together with other salts as supplementary on a ration very low in mineral constituents, grew to be animals of 280 pounds weight, bore litters of fairly vigorous pigs, which on the same ration completed the cycle back to 80 pounds, while animals on the same ration, less the inorganic phosphate, collapsed in three months with loss of weight and use of limbs. Some of the more important observations made are as follows: (1) Animals on a ration extremely low in phosphorus made as large gains up to 75 to 100 pounds as did animals receiving an abundance of this element. After reaching this point loss of weight began, followed by collapse. (2) When such low phosphorus rations as induced the above symptoms were supplemented with inorganic phosphates, no untoward results appeared. Animals fed a low phosphorus ration, supplemented with inorganic phosphates, made as vigorous a development as others receiving wholly organic phosphorus. (3) Determinations of calcium and phosphorus in the principal organs and tissues of the animals on the low phosphorus ration showed that they maintained their composition normal. The per cent. of ash in the skeletons of pigs on a depleted phosphorus ration was reduced to nearly one half that of pigs which received a normal ration, or the phosphorus-poor ration plus inorganic phosphates. When the animals were starving for phosphorus they drew it from the skeleton, but always removed calcium and phosphorus in the proportions found in tri-calcium phosphate.

The Importance of Digestion in the Utilization of Cane Sugar: ISRAEL S. KLEINER.

The average output of saccharose after intraperitoneal or subcutaneous introduction into dogs under various experimental conditions was found to be 65 per cent. to 75 per cent. in a large number of experiments. The extremes were 37 per cent. and 99 per cent. There is some evidence that the portion not recovered is not all excreted into the intestine, but is metabolized within the body.

Effect of the Ratio of Magnesium to Calcium on the Roots of Seedlings: BURD L. HARTWELL and F. R. PEMBER.

Magnesium nitrate has been found to be toxic to wheat seedlings; the addition of calcium and

potassium has been found to lessen the toxic effect of magnesium salts. The leafy portion of the seedlings appeared normal. The toxicity of the magnesium salts was shown by comparing growths in these solutions with those in distilled water. The toxic effect of magnesium is greater when there is a deficiency in potassium. Lime added to such solutions is beneficial, but is not believed to be a substitute for potassium.

Abstracts have not been received for the following papers:

The Spontaneous Oxidation of Cystein and Cystin: ALBERT P. MATHEWS.

Investigations on Wheat Oil: JOSEPH S. CHAMBERLAIN and GEORGE L. BIDWELL.

Phosphorus Metabolism Experiments: F. C. COOK.

Artificial Digestion with Organic Acids and with Essential Oils: EDWARD GUDEMAN.

Hydrolyses of Carbohydrates with Blood Serums: EDWARD GUDEMAN.

Composition of Cold-stored Poultry: M. E. PENNINGTON.

On Nucleic Acids: P. A. LEVENE.

The Digestibility of Corn Meal: L. H. MERRILL.

INORGANIC CHEMISTRY

PHILIP E. BROWNING, *Chairman*

The Estimation of Potassium in Soils as the Cobalti-Nitrite: W. A. DRUSHEL.

It was first shown by Karl Gilbert, of Tübingen, ten years ago that potassium is quantitatively precipitated by sodium cobalti-nitrite as the double cobalti-nitrite of sodium and potassium, if the mixture is allowed to stand from 10 to 20 hours. Two years later Adie and Wood used the same reagent for the quantitative estimation of potassium, decomposing the precipitate by boiling with dilute sodium hydroxide, and titrating the nitrites with standard potassium permanganate. Their method has been shortened by evaporating the mixture nearly to dryness after adding an excess of sodium cobalti-nitrite, instead of allowing it to stand 10 to 20 hours, and by oxidizing the precipitate after washing well with a sodium chloride solution, directly with dilute, hot, standard permanganate instead of decomposing the precipitate and removing the cobalt. The oxidation is completed by acidulating with dilute H_2SO_4 , the excess of permanganate bleached with standard oxalic acid and the solution titrated to color with permanganate. One cubic centimeter of decinormal perman-

ganate is equivalent to .000857 gram K_2O , since the cobalt is reduced from the trivalent to the bivalent condition. For potassium in soils a weighed amount of soil is digested with 20 per cent. HCl ; the extract is evaporated to dryness and gently ignited to remove any ammonium chloride and organic matter present. This residue is then extracted with water acidulated with acetic acid. The extract thus obtained is treated with concentrated sodium cobalti-nitrate and the process carried out as previously indicated.

Potassium in Animal Fluids as the Cobalti-nitrite: W. A. DRUSHEL.

For potassium in urine the dried residue from a measured quantity is treated with a 9:1 nitric-sulphuric acid mixture in a covered platinum dish over the steam bath. After the violent oxidation is over the cover is removed, and the solution evaporated to dryness. The residue is then ignited, gently at first and finally at the full heat of the bunsen burner. In the case of protein-containing fluids, as the blood, lymph, serum and milk, it is preferable to oxidize the dried residue with concentrated nitric acid alone over the steam bath. The solution is then evaporated to dryness, gently ignited, moistened with concentrated H_2SO_4 , and ignited as in the case of urine. The residue thus obtained contains nothing which might interfere with the cobalti-nitrate method; it is, therefore, dissolved as may be over the steam bath with a little water acidulated with acetic acid, and, without filtering, the solution is treated with an excess of sodium cobalti-nitrite. From this point the process is carried out as described for soils. The cobalti-nitrite method is applicable in the absence of mineral acids and the salts of ammonium, cesium, rubidium and thallium. The method is rapid and for small amounts of potassium compares favorably with the chlorplatinate method if proper care be taken in washing and oxidizing the precipitated potassium sodium cobalti-nitrite, the chief sources of error being the slight solubility of the precipitate (1 part in 25,000 to 30,000 of water) and in its tendency to include traces of sodium cobalti-nitrite. In this work the chlor-platinate method was used as a control.

Electrolytic Determination of Nitric Acid: OWEN S. SHINN.

It was found that by keeping copper in solution, either by the addition of copper sulphate during reduction, or by retarding the speed at which the anode rotates, the nitric acid is completely reduced to ammonia. This may be de-

terminated either by distilling or by titrating excess of acid. Results are almost theoretical.

Observations of Columbium: C. W. BALKE and E. F. SMITH.

This investigation forms an additional chapter in the study of columbium which has for some time been receiving attention in the laboratory of the University of Pennsylvania. It shows that by crystallization of columbium potassium from 35 per cent. hydrofluoric acid titanium may be completely eliminated. A new method for the preparation of columbium pentachloride passing SnCl_2 vapors over columbic oxide is described in great detail. The vapor density of the columbid, CbCl_5 , is also determined. Numerous analyses of it are also given. The atomic weight of columbium, by decomposition of CbCl_5 with water, was determined. The value after all corrections was found to be 93.5. A series of columbates of the ratio 1:1— R_2O , Cb_2O_5 was prepared and minutely studied. Columbates of the ratio 4:3 were also investigated chemically and crystallographically. A third series in which the ratio is 7:6, $7\text{K}_2\text{O} \cdot 6\text{Cb}_2\text{O}_5$, was also investigated. The following percolumbates were obtained: Na_3ClO_5 , Pb_3ClO_5 , $\text{MgNaClO}_5 \cdot 8\text{H}_2\text{O}$, $\text{CaKClO}_5 \cdot 4\text{H}_2\text{O}$, K_3ClO_5 , CO_3ClO_5 . The double fluorides of columbium received an exhaustive and thorough review. Pertantalates, analogous to percolumbates, were prepared and analyzed.

The Separation of the Alkali Metal in the Electrolytic Way: J. S. GOLDBAUM and E. F. SMITH.

By means of a mercury cathode and rotating silver anode not only have chloride of the alkaline earth and alkali metals (sodium and potassium) been analyzed, but ammonium halides have been successfully and quantitatively determined. The decomposition values of rubidium and cesium halides have been ascertained and sodium has been separated from ammonium potassium rubidium and cesium. Potassium has been separated from cesium and rubidium. Rubidium and cesium have been separated in this way. The time for this has been greatly reduced. The results have been exceedingly accurate. At present lithium halides are receiving attention.

Specific Gravity and Valence: ARTHUR J. HOPKINS.

Meyer's curve of atomic volumes calls for a symmetrical arrangement of the periodic system, a form of which is suggested. The periodicity of the curve is then shown to be due to the item specific gravity alone. The curve for specific volume is shown to have the same character as

Meyer's, the characteristics of which entirely disappear when the figures for specific volume are multiplied by volume or, more exactly, by position number on the periodic system suggested. It is shown that the position number is more important than atomic weights in calculations of certain physical properties.

A System of Qualitative Analysis for the Common Elements. V. Detection of the Acidic Constituents: ARTHUR A. NOYES and ROGER D. GALE.

In the process described by the authors all the volatile acids are separated from the basic constituents by distilling the substance with a mixture of 10 c.cm. of 85 per cent. phosphoric acid and 20 c.cm. of water. The distillate is divided into two equal portions, the former being collected in barium hydroxide solution, and the latter in water. The first portion contains the weaker and more volatile acids, H_2CO_3 , H_2SO_3 , H_2S , HCN , HNO_2 , as well as free halogens; the second portion contains the stronger or less volatile acids, HCl , HBr , HI , HSCN , HF and HNO_3 . General and special tests for these constituents are applied separately to the two distillates. By adding copper and continuing the distillation of the substance with the concentrated phosphoric acid, sulphates are reduced to sulphurous acid, and this is collected in water as a third distillate and tested for with barium chloride and bromine water. Boric acid is also distilled over by boiling a separate portion of the substance with methyl-alcohol and sulphuric acid, the alcoholic distillate being tested by the addition of hydrochloric acid and turmeric solution.

Certain Organic Acids and Anhydrides as Standards in Alkalimetry, Acidimetry and Iodimetry: ISAAC K. PHELPS.

The paper is a continuation and extension of my paper with Hubbard on succinic acid as a standard; in that paper ammonium hydroxide with cochineal as an indicator was used; now I show that succinic acid, or anhydride, malonic acid, benzoic acid, phthalic acid or its anhydride may be used with exactness with sodium hydroxide and phenolphthalein as an indicator and that these same acids and anhydrides may be used also as standards in iodimetry.

Abstracts of the following articles have not been received:

The Estimation of Chromic and Vanadic Acids in the Presence of one Another: GRAHAM EDGAR.

In how far are we justified in assuming the Homogeneity of the Chemical Elements? B. B. BOLTWOOD.

The Action of Light on Water of Crystallization: RALPH H. MCKEE and ELVIN J. BECKHEISER.

The Estimation of Cerium in the Presence of the Other Rare Earths by Potassium Ferricyanide: PHILIP E. BROWNING and H. E. PALMER.

The Perchlorates of Hydrazine: A. W. BROWNE and J. W. TURRENTINE.

The Electrolysis of Anhydrous Hydronitic Acid: A. W. BROWNE and G. E. F. LUNDELL.

On the Question of the Existence of Lead Sub-oxide: DAVID WILBUR HORN.

A System of Qualitative Analysis for the Common Elements. IV. Analysis of the Alkaline-Earth and Alkali Groups: WM. C. BRAY.

The Estimation of Vanadium by Permanganate after Reduction by Titanous Sulfate: H. A. NEWTON.

The Action of Bismuth Oxide on Reduced Salts of Vanadium: H. A. NEWTON.

Processes of Differential Oxidation and Reduction Applied to the Estimation of Vanadium, Molybdenum and Iron: GRAHAM EDGAR.

Determination of Arsenic in Insecticides: D. L. RANDALL and F. W. WOODMAN.

The Perchlorates of Hydrazine: A. W. BROWNE and J. W. TURRENTINE.

PHYSICAL CHEMISTRY

FRANK K. CAMERON, *Chairman*

Liquid above the Critical Temperature: W. P. BRADLEY, A. W. BROWNE and C. F. HALE.

The authors, who adhere to the view that liquid does exist above the critical temperature, describe a way in which that liquid can be "seen" in a Cailletet apparatus while temporarily localized by virtue of its greater specific gravity. It forms ripples which flow down the walls of the container, adhering thereto, and accumulating under the unliquefied vapor. Its top may be sharply bounded, though not, of course, by a meniscus. The location of the boundary is marked by the conduct of the ripples as they flow down upon it, and also by that of similar ascending ripples which may be caused by slight evaporation of the liquid, brought about by appropriate increase of volume. These and other phenomena are continuous above and below the critical temperature.

The Relation between the Temperature of Kerosene and the Explosion Pressure of the Supernatant Mixture of Vapor and Air: W. P. BRADLEY and C. F. HALE.

The explosion pressure of the vapor air mixture of two typical samples of kerosene, confined at atmospheric pressure, were measured from the temperature at which explosion first occurred to that at which the mixture was too rich in vapor to explode. Explosion was induced by the electric spark. At the temperature of the Elliot (closed) cup flash point the explosion pressure is already one half the maximum pressure. At that of the Tagliabul (open) cup flash point it is almost equal to the maximum, while in that of the Tagliabul fire point the mixture is rich, so that the explosion pressure is greatly reduced and the danger therefrom is practically over.

Note on the Hydrolytic Dissociation of Nitrobenzene: R. R. RENSHAW.

Attempts have been made to determine the decomposition of nitrobenzene by water at different temperatures and concentrations by the colorimetric estimation of the nitrite formed. A hundredth molar solution is dissociated between 0.003 and 0.004 per cent. at 37°. Equilibrium is only reached after a number of days. The results at higher temperatures in sealed tubes are of no value on account of the alkali dissolved from the glass. This and similar reactions will be studied by the conductivity method.

The Specific Heats of the Elements: J. E. MILLS.

The paper gives a critical summary of the data upon the specific heats of the elements and points out the following conclusions: (1) The specific heats of the elements change rapidly with the temperature, the change being greatest at low temperature and for elements with low atomic weight. (2) It is absolutely hopeless to claim any sort of constancy for the product of the atomic weight of an element and its specific heat at varying temperatures. (3) The value of the atomic heat at the absolute zero is not the same for all substances, but the substances with the larger atomic weight have at that temperature the largest atomic heat. (4) The total energy of a molecule in the liquid condition at its melting point, if its energy at 0° absolute be considered zero, is approximately three times the kinetic energy of the same molecule were it a gas at that temperature. (5) It is suggested that the law of Dulong and Petit is only a special case of an equation similar to the equation for gases, in which the molecular heat at

constant volume, multiplied by the ratio of the specific heats less than one, is equal to $2K$ where K is the gas constant.

Some Relations at the Critical Temperature: J. E. MILLS.

It was shown that if the density of a liquid be plotted against the temperature the line drawn through the density where it varies linearly with the temperature will, if prolonged, cut off on the ordinate line at the absolute zero just twice the distance that it cut off on the ordinate line at the critical temperature, and this line intersects the temperature axis at a point equal to twice the critical temperature. Moreover, the line of mean density of liquid and saturated vapor discovered by Cailletet and Mathias likewise meets the temperature axis at the same point (twice the critical temperature). The critical density is therefore one fourth of the density of the liquid at absolute zero.

The Relation of the Rate of Settling to the Size of Particles in Suspension: E. E. FREE.

Most investigators of sedimentation phenomena have worked with very fine powders where the factors effecting the rate of fall are exceedingly complex. This paper describes an attempt to study the much simpler case of the fall of relatively coarse particles. Quartz sand of various sizes was dropped through distilled water in a long tube and the velocity of fall measured between points a meter apart. It is shown on theoretical grounds that for spherical particles the relation of velocity and size of particle is given by the equation $V^2 = Kr$ where K is a constant. Taking the value of K as found for the coarsest particles (which are least likely to be subject to disturbing influences), the theoretical parabola is plotted and it is shown that the points for powders less than .25 mm. in diameter lie far above the curve. That is, the finer powders fall more slowly than would theoretically be expected. This is probably due in part to the action of secondary forces and in part to the fact that finer grains are more angular and do not approach the spherical form so nearly as do the coarser. With the finest powders flocculation comes into play and again increases the rate of fall.

The Aluminum Cell for preventing Underground Electrolysis: F. E. GALLAGHER.

After a brief discussion on prevention of underground electrolysis, experiments with a cell containing electrodes of aluminum and lead in a

sodium acid phosphate solution were described. The length of time a "formed" aluminum electrode is held cathode determines the extent to which a film decays, and therefore the time required to build up a high resistance when such an electrode is again made anode. The effectiveness of an aluminum anode in checking current is less at low impressed voltage. Under continued direct current action both the lead anode and aluminum cathode are attacked in sodium acid phosphate solution. Carbon instead of lead in phosphoric acid solution would prove more serviceable.

The Specific Heat and the Latent Heat of Vaporization of Silicon Tetrabromide: L. KAHLENBERG and E. H. ZOBEL.

The silicon tetrabromide was prepared by passing bromine over heated metallic silicon. The product was freed from excess of bromine by fractional distillation, treatment with metallic mercury, and finally redistilling. The boiling point of the purified product was 148.7° at 736 mm. pressure. The specific heat between the temperatures of 24° and 144° was found to be 0.10055, and the latent heat of vaporization was found to be 28.86. The method for determining the specific heat was that employed by Berthelot, and the method of Kahlenberg was used in making the determinations of the latent heat of vaporization. The figures obtained are the mean of several determinations that gave closely agreeing results.

Equilibrium in the System Silver Chloride and Pyridine: LOUIS KAHLENBERG and WALTER J. WITTICH.

There are two distinct crystalline compounds of silver chloride and pyridine, namely, $\text{AgCl} \cdot 2\text{C}_5\text{H}_5\text{N}$ and $\text{AgCl} \cdot \text{C}_5\text{H}_5\text{N}$; these have hitherto been unknown. The former compound is stable between -56° and -22° C. It was obtained in minute crystals that are very unstable at temperatures above -22° C. $\text{AgCl} \cdot \text{C}_5\text{H}_5\text{N}$ is stable between -20° and -1° C. The salt forms small needlelike crystals which are more stable than $\text{AgCl} \cdot \text{C}_5\text{H}_5\text{N}$. From -1° to 110° C. the solubility of AgCl in pyridine decreases rapidly as the temperature rises. The entire equilibrium curve of the system silver nitrate and pyridine has been established from the freezing-point of pyridine up to 110° C.

The Validity of Faraday's Law at Low Temperatures: WENDELL G. WILCOX.

The experiments were made on silver nitrate

solutions in pyridine. The conclusions reached are that the electrochemical equivalent of silver is independent of the temperature and that Faraday's law holds for temperatures as low as -55° C. provided secondary changes taking place at the electrodes are taken into consideration.

Replacement of Heavy Metals in Non-aqueous Solutions by Metallic Calcium: J. H. WALTON, JR. (Preliminary Report.)

A series of experiments have been carried out for the purpose of determining whether or not a strongly metallic substance, such as calcium, is able to replace the heavy metals of salts which are dissolved in non-aqueous solvents. As a typical heavy metal copper was selected, the oleate being the salt used because of its solubility in a large number of solvents. The experiments were carried out by heating the solution at 100° in a sealed tube with a strip of metallic calcium, the surface of which had been scraped until bright. The following solvents were used for the copper oleate: Toluene, xylene, pyridine, carbon tetrachloride, ethylene bromide, turpentine, paraffine oil, lard oil, carbon bisulphide, aniline, nitrobenzene, amyl acetate. The calcium was tarnished, but in no case was it coated with copper. Calcium heated with fused copper oleate at 150° for two hours also did not precipitate copper. A number of similar experiments were carried out in which the following alloys of calcium were heated with solutions of copper oleate in the above solvents: Ca-Zn, Ca-Cd, Ca-Pb, Ca-Sn, Ca-Bi, Ca-Sb, Ca-Al, Ca-Hg. In the case of the alloys containing Pb, Zn and Cd, respectively, replacement of the copper was observed in pyridine solution; with the other alloys this did not happen. This is in accordance with the observations of Sammis, who found that these metals when heated with certain copper oleate solutions precipitate the copper. In the case of the Ca-Pb alloy it was observed that whereas metallic lead causes the precipitation of Cu only on heating at 100° —the Ca-Pb alloy is coated with copper after standing a few minutes at room temperature. The action of the alloys of Ca is being made the subject of further investigation.

The Absorption of Carbon Dioxid by Certain Bases: F. K. CAMERON and W. O. ROBINSON.

The pressure curves of CO_2 over various metal hydroxids at 0° C. up to 5 atmospheres pressure were determined. It is shown that solid bicarbonates of lime, magnesia and ferrous oxide and carbonates of alumina, ferric oxide and beryllia do not exist under the forenamed conditions.

The Dry Grading of Powders: E. E. FREE.

It is often necessary to grade a powder without wetting it. Bolting cloths are useful for coarser powders, but not for finer. Air elutriation has been used technically to meet this problem and has been used for scientific purposes by Cushman and Hubbard.¹ This paper suggests an improvement of their apparatus, in that the stream of air carrying the suspended powder is introduced into the smallest of a series of percolation jars and passes through them successively in order of increasing size (instead of the reverse). The velocity of the air stream thus decreases from jar to jar and finer and finer powders are deposited in each. The main trouble with this apparatus is due to flocculation of the powder. The finer grains stick to the larger and to the sides of the apparatus and the only fraction which is entirely of the size desired is the last, or finest fraction. The intermediate grades all contain a small amount of finer material. This flocculation is mainly due to water films on the particles and to electrical charges. That due to water is decreased by drying, but this increases the electrical flocculation. The minimum of flocculation is found when air and powder are almost, but not quite, dry.

The Solubility of Basic Copper Carbonate in Solutions of Carbon Dioxide: E. E. FREE.

The investigations detailed in this paper form part of the studies on the effect of copper salts in irrigating waters, which have been in progress for several years at the Arizona Agricultural Experiment Station. It is shown that the compound precipitated from solutions of carbonates and copper salts is of variable composition, but that under the action of carbon dioxide and water for several days it changes to a compound of definite solubility and probably definite composition. The $\text{CuO}:\text{CO}:\text{H}_2\text{O}$ ratio (molecular) of this compound is 1.000: .515: .603. Its solubility in water is greatly increased by the presence of carbon dioxide. With 1,200 parts of carbon dioxide per million about 35 parts of copper per million dissolve. The solubility in solutions of carbon dioxide is increased by the presence of sodium chloride, sodium sulphate and probably calcium sulphate, and is depressed by the presence of sodium or calcium bicarbonate.

The Constitution of Alum Molecules in Solution: CHAS. L. PARSONS and W. W. EVANS.

Diffusion experiments with iron, aluminum and chromium alums, both with membranes and agar

¹*J. Amer. Chem. Soc.*, **29**, 589-597 (1907).

agar, showed that the constituents of the molecules of the alums separate from each other readily by diffusion at both 0° and 25°.

The Constitution of Solutions of Iodine in Aqueous Potassium Iodide: CHAS. L. PARSONS and GEO. A. PERLEY.

Diffusion experiments with solutions of iodine in aqueous potassium iodide, using membranes or agar agar, show that the potassium iodide and the iodine diffuse independently of each other in both dilute and concentrated solutions.

The Inversion of Cane Sugar by Invertase: C. S. HUDSON.

It is shown that in dilute solutions the inversion is a unimolecular reaction, following accurately the logarithmic formula. The real rate can not, however, be measured in a polarimeter unless the solution is made alkaline before each reading, as otherwise the apparent rate of inversion is observed which differs from the real rate by as much as 50 per cent. Henri, Armstrong and others who claim that the actions of invertase and of other enzymes differ from the usual types of catalysis, have measured the apparent rate rather than the real rate. The investigation is being continued and a preliminary notice of it may be found in the July number of the *Journal of the American Chemical Society*.

Abstracts for the following papers have not been received:

Precipitation of Copper from Chloride Solutions by Means of Ferrous Chloride: GUSTAVE FERNEKES.

Precipitation of Copper from Chloride Solutions by Means of Ferrous Chloride and its Relation to the Genesis of the Michigan Copper Deposits: GUSTAVE FERNEKES.

Equilibrium in the System—Potassium Iodide, Iodine and Ethyl Alcohol: CHAS. L. PARSONS and GEO. A. PERLEY.

The Velocity of Reactions in Gases moving through Heated Tubes and the Effect of Catalysis: IRVING LANGMUIR.

An Automatic Regulator for Electric Currents: IRVING LANGMUIR.

On the Mechanism of the Formation of Esters from Alkyl Halides and Salts of Organic Acids: S. F. ACREE and F. M. ROGERS.

The Dissociation Pressures of Certain Oxides at High Temperature: P. T. WALDEN.

A Physico-chemical Study of the Phosphoric Acids: G. A. ABBOTT.

The Use of the Conductivity Method in Testing Nicotin Solutions and Tobacco Extracts: HARRIS E. SAWYER.

Studies in Electromotive Force: G. N. LEWIS.

The Reduction of Cadmium by Mercury and the E.M.F. of Cadmium Amalgams: G. A. HULETT and R. E. DELURY.

Cadmium, Cadmium Sulfate and its Solutions: G. A. HULETT.

Types of Electrolytes: J. JOHNSTON.

The Hydration of Ions: E. W. WASHBURN.

Negative Viscosity: FREDERICK H. GETMAN.

Latent and Specific Heats of Some Fused Salts: H. T. KALMUS.

The Behavior of Colloidal Metals with Immiscible Solvents: W. LASH MILLER.

Solutions of Metals in Liquid Ammonia: C. A. KRAUS.

Electrolytic Reduction of Permanganate Solutions: J. W. TURRENTINE.

Mercury Cathodes in Nitric Acid Solutions: J. A. WILKINSON.

On Vapor Pressures: O. F. TOWER.

On the Electrolytic Oxidation of Hydrazine Sulfate: J. W. TURRENTINE.

Action of Ferric Sulfate on Copper: C. G. SCHLUEDERBERG.

Experiments with Halogen Carriers: C. G. SCHLUEDERBERG.

The Source of the Thorium Disintegration Products Present in the Atmosphere: BERTRAM B. BOLTWOOD.

The Presence of Lead in Autunite and Other Secondary Uranium Minerals: BERTRAM B. BOLTWOOD.

The Capillarity of Mercury in the Presence of Vapors: MORRIS LOEB and STEPHEN R. MOREY.

Determination of the Vapor Tension of Solutions by Means of the Morley-Brush Gauge: O. F. TOWER.

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